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TITLE Teachers' Mathematics Attitudes as a Mediator of Students' Attitudes and Achievement.
PUB DATE Apr 77
NOTE 18p.; Paper presented at the annual meeting of the American Educational Research Association (New York, New York, April 4-8, 1977)

EDRS PRICE MF-$0.83 HC-$1.67 Plus Postage.
DESCRIPTORS *Achievement; *Attitudes; *Educational Research; Elementary Education; *Elementary School Mathematics; Elementary School Teachers; Mathematics Education; Teacher Attitudes
IDENTIFIERS Research Reports

ABSTRACT

Aiken's Mathematics Attitude Scale (MAS) was administered to 70 elementary school teachers; achievement and attitude data were collected from seven randomly selected students of each teacher. Change in student attitudes and achievement during the school year were considered in relation to teachers' scores on the two subscales of the MAS; these subscales are Enjoyment of Mathematics and Value of Mathematics. Results indicated that students' attitudes and achievement were unrelated to their teachers' scores on the value subscale. However, there was a significant positive relationship between teachers' enjoyment of mathematics and students' achievement. (SD)

TEACHERS' MATHEMATICS ATTITUDES AS A MEDIATOR OF STUDENTS' ATTITUDES AND ACHIEVEMENT

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Paper presented at the Annual Meeting of the American Educational Research Association, New York City, April 1977. The original study was supported by funds provided by the National Science Foundation under Grant No. EPP74-14535 A02.

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The importance of teachers' attitudes toward mathematics has been advanced for many years (Taylor, 1930; Anderson, 1956; Banks, 1964; Aiken, 1976). Yet the relationship of teachers' attitudes with pupils' attitudes and performance remains unclear. While Alpert, Stellwagon and Becker (1963) have found that students' attitudes toward mathematics were generally more favorable when the teacher was perceived as theoretically oriented and "involved" with teaching, a major problem exists in this type of research. Obtaining information about teacher characteristics from students' reports raises questions of whether the student reports are accurate perceptions of teacher characteristics or are mediated by the students' attitudes and performance. Similar research relating students' attitudes to students' perceptions of teachers' attitudes and behavior involving college students who disliked mathematics (Aiken and Dreger, 1961) and a sample of junior and senior high school students (White and Aaron, 196[illegible]) experienced the same problem.

More direct evidence concerning the relationship of teacher characteristics and attitudes with the attitudes toward mathematics of their students have generally shown non-significant

relationships (Caezza, 1970; Wess, 1970; Van de Walle, 1973). There is, however, recent evidence to suggest that students' attitudes are affected in varying degrees by the differential attitudes and behavior of their teachers (Starkey, 1971); in fact, Phillips (1973) found that teachers' attitudes for two of the past three years, and especially the most recent teachers' attitudes, were significantly related to students' attitudes toward arithmetic.

The relationship of teachers' attitudes to pupils' performance has in some cases indicated that quantitative thinking and functional competence are higher for groups associated with teachers who have demonstrated more favorable attitudes toward mathematics (McCardle, 1959). Other studies have shown the relationship to be more complex. Peskin (1965) has concluded that there is an interaction between teachers' attitudes and understanding since he found that teachers with a "middle" attitude and a "high" understanding of the content area had students with the best scores on a geometry achievement test, but teachers with "high" understanding and "low" attitudes had students with the poorest achievement in both arithmetic and geometry.

Perhaps the above-mentioned study of Phillips (1973) contains the key issue which has been problematic in the findings to date. Research has tended to view the relationship of teachers' attitudes toward mathematics and their students' attitudes and performance without reference to the prior attitude or achievement levels of the students involved. The present study was undertaken to examine the relationship of teachers' attitudes

to their students' attitudes and achievement with this in mind. Specifically, this study is concerned with the effects of teachers' mathematics attitudes on the mathematics attitudes and achievement of students where the effects of previous mathematics instruction, instructors, and experiences have been isolated.

Sample

Data were collected from 70 elementary school teachers (grades two through six) in four northern New England school districts. Each of the cooperating teachers had been randomly selected from a group which had volunteered to participate in a National Science Foundation sponsored study of alternative approaches to inservice mathematics training.[1] Data were also obtained from a random sample of seven students from each of the participating teachers' classes. The student sample was reduced to 412 due to relocation during the nine-month testing period and also because of incomplete data for individual subjects. The teachers and students involved in this study included members of both the experimental and control groups of this larger study.

Instrumentation

The Mathematics Attitude Scale (Aiken, 1974) was administered as a measure of teachers' attitudes. This Likert

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scale is comprised of two subscales. The first subscale consists of 11 items designed to measure Enjoyment of Mathematics; the second subscale contains 10 items designed to measure Value of Mathematics. Alpha coefficients reported by Aiken for the two subscales were .95 and .85, respectively, and item-total correlation indices surpassed .75 for the Enjoyment Scale and .60 for the Value Scale. Analyses of the responses of the 84 teachers involved in the original sample of the present study (including 14 grade one teachers) resulted in similar estimates of internal consistency but lower item-total correlations for the subscales (Archambault, Nolen and Greene, 1976). The alpha coefficients for the Enjoyment Scale and the Value Scale were .92 and .79, respectively. The item-total correlations for the Enjoyment Scale ranged from .36 to .86 with seven of the eleven coefficients exceeding .75. The Value Scale item-total coefficients were bounded by .29 and .66 with only one of the ten coefficients above .60. Although these coefficients were less than the corresponding coefficients for Aiken's sample, each correlation was in the range of respectable discriminators (Ebel, 1967).

The bidimensionality of the Mathematics Attitude Scale was further supported by factor analysis findings pertaining to the 84 teachers. Utilizing squared multiple correlations as initial estimates of communalities, six factors were generated by an oblique rotation of the factor pattern. These six factors subsequently yielded two factors commensurate with the two dimensions advanced by Aiken when exposed to a second-order factor analysis.

A semantic differential scale was employed to measure student attitudes toward mathematics (Mastantuono and Anttonen, 1971). This scale consists of 12 bi-polar adjective pairs, each of which is separated by five response options. Item and factor analytic procedures were applied to the pretest data to determine appropriate scoring procedures (Archambault, Greene and Nolen, 1975). The initial factor analyses considered failed to yield a meaningful structure for the full scale of 12 items. Subsequent item analyses revealed that six items were not related to total scores. Upon deleting these items, the revised scale yielded satisfactory item-total correlations ranging from .50 to .80. The alpha coefficient of internal consistency was .80. Moreover, when this six-item scale was factor analyzed using both a classical model with squared multiple correlations as estimates of communalities and a principal component model, each model produced a consistent, single-factor structure. Consequently, the scale was scored using only the six meaningful items. These were the bi-polar adjective pairs: happy-sad, bad-good, nice-awful, cruel-kind, fair-unfair, and dislike-like.

The 1973 revised version of the Stanford Achievement Tests was used to measure student achievement in mathematics. According to the developers of the battery, the revised forms reflect the significant mathematics curriculum changes as implemented in today's schools. Five levels of the test series were administered in accordance with the developers' instructions. The internal consistency of each of the subscales at each level has been found to be high. The odd-even split-half

reliabilities, as adjusted by the Spearman-Brown Formula, range from .81 to .93. Kuder-Richardson estimates of internal consistency were bounded by .81 and .92. Scaled scores based upon the total raw scores were used for the regression analyses described in the next section of this paper.

Statistical Analysis

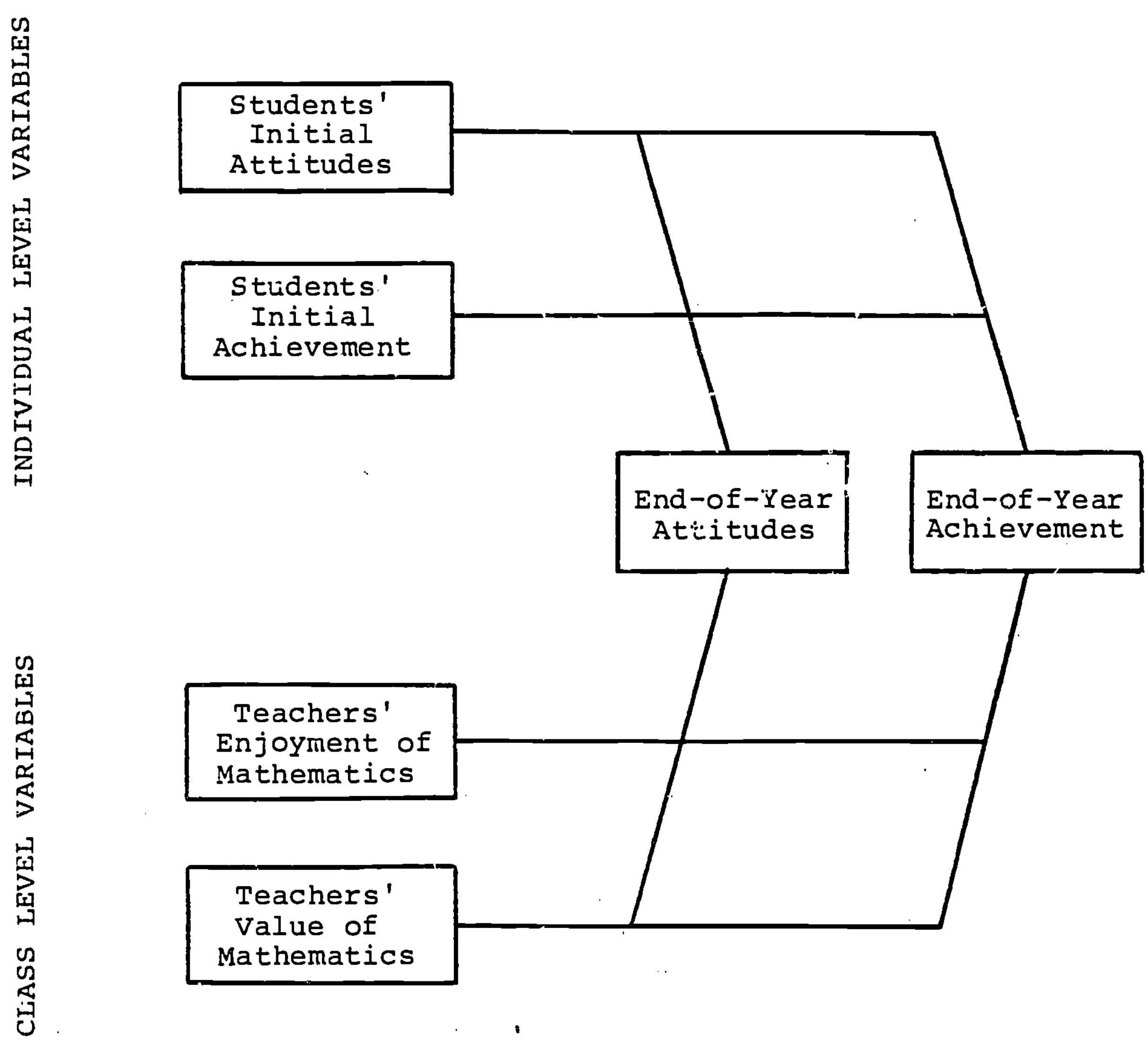
Data for this research were analyzed at two levels. First, individual level analysis sought to explain those components of students' attitudes and achievement which could be attributed to the entry level attitudes and achievement of each pupil. This was accomplished through the implementation of two regression models, one for which end-of-year student achievement was the dependent variable and the other for which end-of-year student attitude was the criterion. Entry level attitudes and achievement were used as independent variables in both models. This procedures attempts to establish the veridicality of the overall model relating teachers' attitudes to the attitudes and achievement of their students by systematically ruling out other explanatory variables of the same relationships, a practice pointed out by Tukey (1954) and later by others (Kerlinger and Pedhazer, 1973; Cohen and Cohen, 1975).

The second phase of the analysis deals with the relevant variables at the class level. Class means of the residual scores of the students' attitudes and achievement resulting from the previous level of analysis were obtained and entered into new regression equations as criterion variables. The independent

measures were the respective classroom teachers' scores on the Enjoyment and Value subscales of the Mathematics Attitude Scale (Aiken, 1974). This analysis then yielded the portion of variance of the means of the classes on the residualized attitude and achievement scores explained by teachers' Enjoyment and Value subscale scores. The analysis model is summarized in Figure 1 below.

FIGURE 1

Analysis Model



Results

Results of the first level of the analysis demonstrated that students' initial attitudes and achievement accounted for 16.8% and 51.8% of their end-of-year attitudes and achievement, respectively. It should be noted that the multiple correlation coefficient of .41 using initial levels of achievement and attitude as explainers of end-of-year attitude reflects virtually only the effect of the attitude pre-measure. That is, the contribution of the initial achievement measure to the explanatory model is negligible. This reflects the low relation present between attitudes and achievement for the student in this study, a finding in keeping with existing research (Anttonen, 1968; Evans, 1971). The same result, of course, is demonstrated by the model which used achievement as the criterion measure, i.e., the initial attitude measure contributed negligibly to the resulting multiple correlation of .73.

Having accounted for this portion of the variance, the second level of the analysis demonstrated that one component of teachers' attitude toward mathematics, the Enjoyment subscale, was a significant contributor to class achievement ($R=.25$, $F_{1,68}=4.28$). When the second dimension of teacher attitude, the Value subscale, was added to the model, the addition to the explained variance was not significant. This result appears to be attributable to the lack of relationship of the Value dimension of teachers' attitudes toward mathematics with their students' achievement, rather than to a strong relationship between the two dimensions of teacher attitude (the

correlation of teachers' Enjoyment subscale with their Value subscale was a modest .40).

Analysis of teachers' attitudes with reference to the residualized attitude scores of their students showed no significant results. Neither the Enjoyment nor the Value dimension of teacher attitude contributed significantly to an explanation of students' end-of-year attitudes.

Conclusions

While general acceptance of the importance of teachers' attitudes toward mathematics has been reflected in literature relevant to students' attitudes and performance, empirical evidence of their importance has been limited. Evidence was presented earlier to support the presence of a relationship between teachers' attitudes and attitudes of their students when teachers' attitudes from several years were considered (Phillips, 1973). Yet the results of the present study indicate that neither the Enjoyment nor the Value dimension of teachers' attitudes relate to the attitudes of their students even when prior experience of the students has been explained and isolated, a finding that supports the research which has shown non-significant relationships between teachers' and students' attitudes (Caezza, 1970; Wess, 1970; Van de Walle, 1973).

Perhaps partial explanation for this result lies in the lack of stability of elementary school children's expressed attitudes. Stability estimates of the attitude measure within

grade were in the range of .42 to .46 for grades three through six and a volitile .27 for the second graders. It should also be noted that the effect of a crystalization of attitude as postulated by Mosher (1952) and Evans (1972) is not evident in these data. While there are only minor differences in stability estimates across grade level, the trend is not linear (i.e., the most stable estimate was achieved at the fourth grade level).

The significant relationship demonstrated in this study between the Enjoyment dimension of teachers' attitudes and class achievement does present, however, empirical evidence of the importance of this dimension of teachers' attitudes toward mathematics. Questions still remain concerning the non-linkage of the Value dimension of teachers' attitudes to students' achievement. Explanation of these relationships may be found in the item configurations of the two dimensions in question. The items which compose each of the two subscales are shown in Tables 1 and 2. Items which comprise the Enjoyment subscale tend to reflect statements of the individuals' feelings concerning mathematics as it relates personally. The Value subscale consists of items which are characterized by exogenous and global statements concerning the worth of mathematics. In terms of explaining the manifest connection between the Enjoyment subscale and students' achievement in mathematics, it seems consistent that the teacher who feels more personally interested and involved with mathematics will be more concerned with current trends in mathematics and may teach with more involvement and enthusiasm.

The fact that a teacher's enjoyment of mathematics contributes to students' achievement when the effects of students' entry levels of attitudes and achievement have been considered provides a basis for pursuing the development of programs directed toward affecting teachers' senses of personal enjoyment of and interest in mathematics.

TABLE 1

Mathematics Attitude Scale: Enjoyment of Mathematics

2. I have always enjoyed studying mathematics in school.

4. Mathematics is enjoyable and stimulating to me.

5. I am interested and willing to use mathematics outside school and on the job.

6. I am interested and willing to acquire further knowledge of mathematics.

7. Mathematics is very interesting, and I have usually enjoyed courses in this subject.

11. I enjoy going beyond the assigned work and trying to solve new problems in mathematics.

12. I would like to develop my mathematics skills and study this subject more.

17. Mathematics is dull and boring because it leaves no room for personal opinion.

18. I have never liked mathematics, and it is my most dreaded subject.

19. Mathematics makes me feel uneasy and confused.

21. Mathematics makes me feel uncomfortable and nervous.

TABLE 2

Mathematics Attitude Scale: Value of Mathematics

1. Mathematics is needed in order to keep the world running.

3. Mathematics has contributed greatly to science and other fields of knowledge.

8. Mathematics is not important in everyday life.

9. Mathematics is not important for the advance of civilization and society.

10. Mathematics helps develop a person'a mind and teaches him to think.

13. An understanding of mathematics is needed by artists and writers as well as scientists.

14. Mathematics is less important to people than art or literature.

15. There is nothing creative about mathematics; it's just memorizing formulas and things.

16. Mathematics is needed in designing practically everything.

20. Mathematics is a very worthwhile and necessary subject.

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